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Date November 20, 2003

To George Y. Wang
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From William E. Booth

Re ARRAY WITH LIGHT-EMITTING POWER SEMICONDUCTOR COMPONENT AND CORRESPONDING PRODUCTION METHOD
Applicant: Bruno Acklin et al.
Application No.: 09/786,699
Filing Date: March 8, 2001
Country: United States
Your Ref.: 1998 P 2530 US N
Our Ref.: 12406-011001

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Message

Attorney's Docket No.: 12406-011001 / 1998 P 2530 US N

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Bruno Acklin et al. Art Unit : 2871
Serial No. : 09/786,699 Examiner : George Y. Wang
Filed : March 8, 2001
Title : ARRAY WITH LIGHT-EMITTING POWER SEMICONDUCTOR COMPONENT AND CORRESPONDING PRODUCTION METHOD

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AMENDMENT IN REPLY TO ACTION OF AUGUST 20, 2003

In reply to the office action date August 20, 2003, please consider the following remarks:

The invention, as claimed in independent claim 1, relates to an arrangement including a light-emitting power semiconductor device. The device is disposed on a substrate, and a plastic protective body is formed by injection onto the substrate and shrouds the device substantially form-fittingly on its sides and top, leaving a light exit region exposed for coupling to an optical waveguide. The region between the light-emitting power semiconductor device and the optical waveguide is filled, at least segmentally, with a transparent plastic material.

Independent claim 16 is directed to a method of making an arrangement involving placing a semiconductor device on a substrate, affixing an optical waveguide to the substrate, injection coating the optical waveguide to completely shroud it in plastic forming a protective body, and exposing a light exit surface of the optical waveguide in the outer periphery of the plastic protective body.

Independent claims 1 and 16 stand rejected under 35 USC 103(a) as obvious in view of Broom U.S. Patent No. 5,516,727 and Tanaka U.S. Patent No. 5,218,611.

CERTIFICATE OF TRANSMISSION BY FACSIMILE

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Broom is cited for disclosure of light emitting device 40 (Fig. 4), substrate 43, plastic protective body 45 (Fig. 4b) and optical waveguide 42. It is admitted that Broom fails to disclose a transparent plastic material in the space between the device and waveguide

Tanaka '611 is cited for disclosure of transparent filling material.

Both references teach away from the invention, and arguments to the contrary in the office action are in error.

In contrast to claim 1, Broom teaches that is is undesirable to hermetically seal a laser chip and thereby fill the gap between a waveguide and a semiconductor chip because this can cause accelerated degradation of the mirror facet of the chip and therefore a shortened life expectancy for the device (col. 1, lines 47-67). To counteract these problems, Broom proposed that an "air" gap or a region filled with an inert gas be provided in direct contact with the light emitting facet of the chip region filled with an inert gas be provided in direct contact with the light emitting facet of the chip (col. 2, lines 10-14). This allows the chip to be completely sealed but avoids an contact between the mirror facet of the chip and the encapsulant (col. 3, lines 63-65). If the chip is to be coupled to an "optical output port" (e.g., an optical fiber which can act as a waveguide), then the gap is located between the mirror facet and the optical fiber so that the optical path remains free of encapsulant (col. 4, lines 34-36).

In the office action it is argued, at page 11, that Broom does not teach away because Broom "teaches that other embodiments [apparently other than the first embodiment] exist without an encapsulant". This statement is inconsistent with the fact that encapsulant is used in the second and third embodiments and is also inconsistent with the statement in Broom at column 1, lines 20-21 that "devices of this nature [i.e. moisture sensitive LED's] <u>require</u> encapsulation and protection by appropriate housing..."

Thus, the Examiner's attempt to discount the teaching away in Broom is in error. If the Examiner still maintains that Broom teaches embodiments without an encapsulant, he is requested to cite the passage in Broom where this is taught.

The Examiner's argument also does not make sense. The novel feature in claim 1 is not the encapsulant but rather the fact that the region between the light-emitting power semiconductor deice and the optical waveguide is filled at least segmentally with a transparent plastic material. Broom supports decreasing optical loss by maintaining a gap filled with gas in direct contact with the light emitting facet of the LED (see col. 2, lines 10-14). In Broom the encapsulant provides the means of achieving this aim, i.e. the encapsulant enables the formation of an "air" gap directly in front of the light emitting facet of the LED. For this reason, and contrary to the assertion of the Examiner, each embodiment in Broom features an encapsulant. In the second embodiment according to Broom, the semiconductor device and the optical waveguide are encapsulated such that an "air" gap exists between the semiconductor device and the optical waveguide. The essential difference between the first and second embodiment according to Broom is that the first embodiment features a part of the encapsulant in the optical path while the optical path of the second embodiment does not contain any encapsulant at all (see figure 4A to 4C where the encapsulant is denoted by the numerals 45 and 46). Therefore, the encapsulant as well as the 'air' gap formed by the encapsulant are essential and indispensable to the teaching of Broom.

Tanaka '611 does not disclose a space between the solid state waveguide 17 of resin material and the semiconductor device as required by claim 1, and teaches away from such a space. Tanaka '611 arranges the resin material waveguide 17 directly in contact with one light emitting face ("rear cleavage face 4Ab") of the laser diode chip so that the signal between the laser diode chip and the monitor element is not altered by contaminants such as dew or dust (col. 2, lines 8-13).

In the office action at page 11, with respect to the Tanaka '611 reference, the Examiner asserts that it is "completely irrelevant" that the Tanaka waveguide is in direct contact with the laser diode. This cannot be irrelevant because the invention according to claim 1 concerns exactly this point, i.e., the position of the waveguide relative to the semiconductor device and more specifically, the space <u>between</u> the waveguide and the semiconductor device.

Furthermore, the Examiner claims that it is nowhere asserted that the waveguide needs to be in direct contact with the laser diode in Tanaka. Paragraph 6 of the Final Office Action itself refers to col. 2, lines 44-56 of Tanaka '611, a passage in which the advantages of filling the space between the light emitting device and the <u>monitor element</u> are described. Furthermore, it is explicitly stated at col. 2, lines 36-40 that a waveguide is formed by covering the space between the light emitting facet of the semiconductor device and the surface of the monitor element with a light transmitting resin. Finally, col. 2, lines 8-12 says that avoiding dew and dust is "an <u>essential object</u> of the invention." In order to realize the advantages and "essential object" described by Tanaka '611, Tanaka '611 advocates that the space between the light emitting facet of the semiconductor device and the surface of the monitor element should be filled with the resin material waveguide.

The essential teaching of Tanaka '611 is that the plastic filling material of the waveguid enables a more accurate control of the output of the laser element because inaccuracies (caused, e.g., by dew and dust formation between the laser and the monitor element) in feedback control are eliminated. More accurate monitoring of the light emitted from the laser enables better control of the required current for driving the laser to achieve the desired laser performance. An inaccurately low monitor reading caused by interference (e.g., dew and dust) can lead to more current being supplied to the laser than necessary and therefore inefficiency of the device as a whole. Tanaka '611 does not deal with reducing optical loss of the laser device as a whole, but rather internal optical loss between the laser element and the monitor element which leads to energy inefficiency of the device as a whole. It is for this reason, that the plastic filling material is located between the <u>rear</u> cleavage of the laser and the monitor element. The external laser output of the component is emitted from the <u>front</u> cleavage of the laser.

Since Broom advocates a gap between the light emitting surface and the waveguide, and Tanaka '611 advocates the filling of the space between the laser and a monitor element with the waveguide material, the two references would not be combined by a person skilled in the art. Even if a person skilled in the art were to combine these two references, he would either put Broom's waveguide in direct contact with the light emitting surface according to the teachings of

Tanaka '611, or he would space the waveguide of Tanaka '611 by a gap according to the teaching of Broom, but would not achieve a device according to claim 1.

Turning now to independent method claim 16, it requires the following third and fourth steps not disclosed in Broom.

> in a third step, said substrate structure with said light-emitting power semiconductor device <u>is injection-coated with a plastic mass forming a plastic protective body</u>, characterized in that in the third step, <u>said optical waveguide is completely shrouded in said plastic protective body</u>, and
>
> in a fourth step, a light exit surface of said optical waveguide <u>is exposed in the region of the outer periphery of said plastic protective body.</u>

The Office Action relies on Fig. 4c for the third step. With respect to Fig. 4c, it is merely said "encapsulant 45 is flowed over laser 40 and fiber 42" (col. 4, lines 29-30). What happens at the end of fiber 42 is not shown in Fig. 4c or described in the text. Presumably the encapsulant ends at the end of base 43 and the fiber continues without encapsulant on it. In any event, there is no disclosure of completely shrouding the optical fiber in encapsulant (the third step) and then exposing a light exit surface in the fourth step.

The subject matters of independent claims 1 and 16 accordingly are nowhere disclosed in or suggested by the cited references, and are allowable under 35 UC 103(a). The remaining claims depend on claim 16 or 18 and are allowable with them.

Please apply any charges or credits to deposit account 06-1050 and include our attorney docket no. 12406-011001.

Respectfully submitted,

Date: Nov. 20, 2003

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